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AGRICULTURAL MEMORANDUM NO. 615

Evapotranspiration from a growing crop with incomplete cover - H A Douglas

The evapotranspiration over a growing crop, for the month of April, was calculated for three crop cover and two soil evaporation schemes as detailed:-

Crop cover schemes

(i) First 10 days with mean crop cover of 10%
Next 10 days with mean crop cover of 40%
Last 10 days with mean crop cover of 70%

(ii) As for (i) with 20%, 50%, 80% respectively

(iii) First 5 days with mean crop cover of 10%
Next 10 days with mean crop cover of 40%
Next 10 days with mean crop cover of 70%
Last 5 days with mean crop cover of 90%

Soil evaporation schemes

(a) As for heavy soils in AG Mem 586

(b) As for (a) except First 4mm at full PE rate
Next 4mm at $\frac{1}{2}$PE
Next 4mm at 1/5 PE
Next 4mm at 1/10 PE, thereafter at 1/20 PE

Data from Cranwell for 1939-68 was used; the evapotranspiration being calculated by adding the respective components of bare soil evaporation and transpiration for each of the crop cover schemes, for the soil evaporation scheme (a). The mean error incurred by using scheme (ii) rather than either (i) or (iii) was 1.7 mm with a maximum error of 3.6 mm (see Table 1). This compares with a mean difference of 19.9 mm between the potential transpiration (PT) and the estimated bare soil evaporation (BSE) (scheme (a)), with a maximum value of 36 mm.

Using the values for soil scheme (a) and crop scheme (ii) the (estimated) evapotranspiration (ET) was found to depend on R = Total rainfall
PT = Potential transpiration for month
N_e = Number of rain days between days 1 and 10 inclusive
N_m = Number of rain days between days 11 and 20 inclusive

Note that rain days are any days on which 0.1 mm (or more) rain fell and are 'thrown forward' as in AG Mem 586.

Then $\frac{ET}{PT} = 70.283 + 13.466\,\frac{R}{PT} + 1.237\,N_e + 0.605\,N_m$ (multiple correlation 0.87)

giving a mean error of 1.6 mm (max error 4.6 mm).

Estimated values using the equation were compared to those obtained by using soil scheme (b) and crop scheme (ii), the mean error being 2.4 mm with a maximum error of 5.9 mm. The equation tested on Goole 1959-68, for crop scheme (ii) and soil schemes (a) and (b) gave mean errors of 2.0 mm and 1.7 mm and maximum errors of 5.1 mm and 4.3 mm respectively (see Table 2).

The results clearly show that the choice of crop cover model or soil evaporation model is, at most, a third order effect. The dominating factor is the total rainfall, with the distribution also having some effect.

Any comments or suggestions on this paper should be referred to the author.

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Meteorological Office
Bracknell

Table 1 Data (in millimetres)

	PT	Bare soil evaporation		Evapotranspiration, using soil scheme(a)		
		Scheme(a)	Scheme(b)	Scheme(i)	Scheme(ii)	Scheme(iii)
Cranwell						
1939	55.9	45.5	42.4	50.9	51.8	52.0
1940	49.5	37.4	33.8	44.1	45.2	46.3
1941	50.8	28.4	25.1	41.2	43.4	44.1
1942	66.0	33.2	30.4	53.1	56.2	57.5
1943	68.6	36.0	34.0	47.1	50.2	52.4
1944	53.3	35.3	31.5	45.1	47.0	47.9
1945	55.9	42.2	39.2	48.8	50.1	51.8
1946	57.1	34.0	29.5	44.2	46.5	46.3
1947	54.6	41.1	38.1	48.8	50.1	51.6
1948	59.7	46.1	42.3	52.5	54.1	54.9
1949	63.5	38.9	34.7	51.5	52.7	53.3
1950	55.9	45.4	42.2	48.6	49.6	50.2
1951	61.0	45.7	41.9	56.2	57.9	58.7
1952	58.4	37.1	33.4	50.4	52.5	53.8
1953	57.1	38.6	35.4	48.6	50.5	50.2
1954	53.3	22.0	19.0	38.5	41.6	43.3
1955	49.5	35.6	32.7	42.3	43.6	43.3
1956	55.9	38.3	34.3	48.2	50.0	49.4
1957	54.6	18.5	15.5	35.6	39.2	40.5
1958	57.1	29.2	26.2	42.6	45.2	46.0
1959	58.4	47.3	42.5	53.5	54.5	54.6
1960	55.9	31.8	28.7	45.8	48.2	48.9
1961	48.3	48.9	45.6	48.7	48.6	48.8
1962	54.6	46.7	42.4	52.5	53.0	53.2
1963	49.5	47.0	44.0	50.8	50.9	49.4
1964	48.3	45.3	42.0	44.4	44.6	48.1
1965	54.6	44.8	41.9	47.6	48.4	48.5
1966	47.0	50.9	48.6	50.2	49.7	49.9
1967	52.1	48.6	45.0	51.1	51.5	51.1
1968	62.2	44,7	40.3	49.5	51.3	52.3

Table 2 Data (in millimetres)

	PT	R	Ne	Nm	Evapotranspiration ET soil scheme(a)	Evapotranspiration Estimate	Evapotranspiration ET soil scheme(b)
Cranwell							
1939	55.9	46.7	5	3	51.8	50.0	49.1
1940	49.5	28.7	7	5	45.2	44.5	43.6
1941	50.8	29.4	5	7	43.4	45.0	41.4
1942	66.0	22.0	10	0	56.2	57.5	54.9
1943	68.6	20.5	2	3	50.2	53.9	48.0
1944	53.3	55.4	6	3	47.0	49,8	45.1
1945	55.9	32.9	4	3	50.1	47.5	48.7
1946	57.1	31.1	2	2	46.5	46.5	44.9
1947	54.6	44.2	8	0	50.1	49.7	48.9
1948	59.7	50.9	7	1	54.1	54.3	52.2
1949	63.5	46.5	5	2	52.7	55.6	50.3
1950	55.9	54.3	4	5	49.6	51.0	47.9
1951	61.0	56.0	8	5	57.9	58.3	56.4
1952	58.4	21.7	8	4	52.5	51.2	50.4
1953	57.1	53.9	7	6	50.5	54.4	49.0
1954	53.3	8.5	5	0	41.6	41.9	39.8
1955	49.5	27.3	6	0	43.6	42.1	42.0
1956	55.9	36.4	3	4	50.0	47.6	48.2
1957	54.6	5.0	3	4	39.2	42.4	37.1
1958	57.1	11.7	4	3	45.2	45.6	43.4
1959	58.4	58.1	5	7	54.5	55.0	52.7
1960	55.9	14.8	4	2	48.2	44.7	46.8
1961	48.3	75.8	8	4	48.6	50.1	47.2
1962	54.6	55.9	8	6	53.0	53.3	51.2
1963	49.5	47.2	5	7	50.9	46.3	49.7
1964	48.3	46.7	4	8	44.6	45.0	42.9
1965	54.6	40.0	4	7	48.4	48.8	46.6
1966	47.0	68.6	7	8	49.7	48.6	48.8
1967	52.1	44.6	8	4	51.5	49.0	50.0
1968	62.2	38.0	3	4	51.3	52.6	49.0
Goole							
1959	55.9	61.0	2	8	54.3	51.6	52.6
1960	53.3	24.9	5	5	50.8	45.7	49.5
1961	47.0	67.7	8	5	48.7	48.2	47.3
1962	48.3	41.0	8	3	47.1	45.1	45.8
1963	43.5	43.5	5	7	45.9	41.0	45.3
1964	49.5	42.8	1	7	43.6	43.3	41.8
1965	52.1	52.1	5	6	49.1	48.8	47.2
1966	40.6	67.4	6	6	42.9	42.1	42.2
1967	50.8	33.9	7	2	48.3	45.3	46.8
1968	61.0	45.8	4	4	53.3	53.6	51.5